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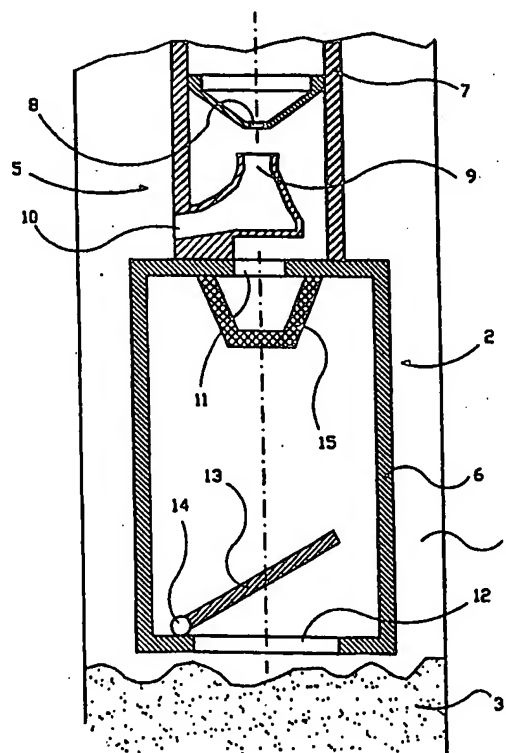
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| <p>(21) International Application Number: PCT/NO98/00310</p> <p>(22) International Filing Date: 14 October 1998 (14.10.98)</p> <p>(30) Priority Data: 974950 27 October 1997 (27.10.97) NO</p> <p>(71) Applicant (for all designated States except US): TESTTECH SERVICES A/S [NO/NO]; Bygg 8, Dusavikbasen, P.O. Box 138, N-4001 Stavanger (NO).</p> <p>(72) Inventor; and (75) Inventor/Applicant (for US only): UNSGAARD, Tom [NO/NO]; Solagt. 20, N-4009 Stavanger (NO).</p> <p>(74) Agents: HÅMSØ, Borge et al.; Håmsø Patentbyrå Ans, P.O. Box 171, N-4301 Sandnes (NO).</p> | <p>(81) Designated States: AL, AM, AT, AT (Utility model), AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, CZ (Utility model), DE, DE (Utility model), DK, DK (Utility model), EE, EE (Utility model), ES, FI, FI (Utility model), GB, GD, GE, GH, GM, HR, HU, ID, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SK (Utility model), SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).</p> <p>Published <i>With international search report.</i></p> | |

(54) Title: **AN APPARATUS FOR THE REMOVAL OF SAND IN AN UNDERWATER WELL AND USE OF A JET PUMP (EJECTOR) IN CONNECTION WITH SUCH SAND REMOVAL**

(57) Abstract

It has been given an account of a sand removing apparatus (2) for use in the lower area of underwater wells (1). The apparatus (2) which is intended to be suspended from the end of a pipe string, comprises, as known per se, a container (6) having a closeable inlet (12) for allowing a flow of liquid accompanied by sand (3) therein. It has been an object to increase the sand container's (6) degree of filling and, thus, capacity. To this end, the container (6) has a separate outlet (11) assigned the suction side of a pump (5) constituting the drive device for the apparatus (2). The drive device is kept going until the degree of filling of the container (6) has been achieved. Between a separate inlet (12) provided with a one-way valve (13, 14) and said separate outlet (11), a filter (15) is disposed, counteracting that sand sucked into the container leaves the same again through a circulating flow together with the carrier liquid. A special use for a liquid-driven jet pump (ejector) (5) is as drive device for such a sand removing apparatus (2).



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AN APPARATUS FOR THE REMOVAL OF SAND IN AN UNDERWATER WELL
AND USE OF A JET PUMP (EJECTOR) IN CONNECTION WITH SUCH SAND
REMOVAL

The invention relates to an apparatus for the removal of
5 sand, especially in the lower area of the well, in connection
with the recovery of oil or gas, said apparatus comprising a
displaceable sand-accommodating container having a closeable
inlet for the sand's flowing into the container and an outlet
10 for removing the sand from the container subsequent to the
displacement thereof, at a suitable place. Likewise, the in-
vention concerns use of a jet pump (ejector) in connection
with such sand removal.

In the production of oil and gas, it is a constantly occurring
problem that sand is torn loose from the formation, accompa-
15 nying the oil and/or gas into the well. Sand following the
flow of oil or gas, so-called produced sand, may cause great
damage on production equipment, both within and outside the
well.

The amount of produced sand increases with increasing flow
20 rate, and an important measure against sand production is,
thus, to limit the flow rate. Measuring equipment has been
developed in order to detect produced sand, so that sand-
reducing measures may be carried out prior to the production

equipment has been damaged to such a degree that it has to be repaired.

Additionally, it is common to strengthen formations easily giving away sand, e.g. by injecting sand to which a binding agent, e.g. sand/gravel admixed an adhesive agent of the type referred to as "glue gravel". Also, known filters of a plurality of types are installable in the well in order to prevent loose sand from accompanying the flow up through the well.

10 After some time's use, the lower part of the well is filled with loose sand, and it becomes increasingly difficult to maintain an acceptable flow rate. Upon maintenance of a well, it it, therefore, usual to try to remove loose sand gathered at the bottom of the well. Loose sand may also result from
15 drilling or other work within the well, and one tries to remove such sand before production start.

A common way of removing sand is to circulate liquid within the well. Liquid pumped down towards the bottom through a pipe string, conveys sand to the surface upon return through
20 the annulus between pipe string and well wall. It is known to add a gas, e.g. nitrogen, to the liquid in order to increase the effect, but it has been found to be difficult to remove sand satisfactorily in this manner.

Also, it is known to fetch up sand by means of a container
25 lowered down into the well to be filled with sand before it is hoisted up from the well. The container is closed at surface level (before being lowered), so that it will contain air or other gas at atmospheric pressure when it arrives to the lower area of the well where the removal of sand is going
30 to be carried out. At the bottom of the well, the container is opened. This may e.g. happen in that an actuation means included in the release mechanism for the closure body of the container inlet which may be assigned a return device towards

closed position, strikes against the well bottom face, thus opening the inlet for a flow of liquid therethrough, bringing sand with it. The well pressure which is substantially higher than the pressure within the container, causes an intense but
5 brief flow of sandy liquid into the container. When the container is lifted out of the well and the actuation means of the release mechanism no longer is resting itself against the well bottom face, the inlet is closed and the sand conveyed up to the surface, kept within the container. The disadvantage of this known apparatus and the filling method of the
10 container is that the degree of filling becomes small and that removal of sand therefore takes much time. When the container partly filled with sand has reached surface level, where the sand is to be discharged, this takes place through
15 the inlet of this known apparatus, the inlet, thus, acting as outlet in this phase of the process.

The object of the invention is to provide a simple and efficient apparatus for removing sand from a well.

The object is achieved through features as defined in the
20 following description and claims.

An apparatus according to the invention comprises a container having two separate apertures. One aperture forms a separate inlet and is assigned a one-way valve so that sandy liquid can flow into the container but not return, out of the con-
25 tainer.

Between the inlet and the other aperture forming a separate outlet, it is disposed a filter to retain sand brought along with the flowing, circulating liquid within the container. Through the establishment of a suction effect within the con-
30 tainer with outflow possibility for sand released liquid, sandy liquid may, thus, be brought to flow into the container at the inlet thereof, filtered liquid flowing out from the container at the outlet thereof and, therefrom, out into the

well. The outlet is assigned the suction side of a pump, preferably a jet pump or ejector, driven by a liquid flow supplied thereto from another pump.

5 The container is lowered into the well and is pulled up therefrom by means of a pipe string, e.g. a coilable tubing coupled to the jet pump. Supplying the jet pump with forced flowing liquid through the pipe string, causes an underpres-
10 sure to be created within the container. Liquid within the well or liquid operating the jet pump in case the well is filled with gas, takes with it sand and flows into the container through the inlet.

The filter prevents sand from accompanying liquid through the outlet and into the pump. The jet pump may, based on experience, be stopped after a predetermined time has lapsed, or
15 upon the occurrence of a signal from a sensor discharging said signal when the container has reached an acceptable degree of filling. When the container is pulled up from the well, said one-way valve prevents sand from falling out through the inlet.

20 In the following, the invention is further described by means of an exemplary embodiment, reference being made to attached drawings, wherein:

Figure 1 is a simplified diagrammatical side elevational view, partly in vertical section, showing a well and a
25 therein disposed apparatus for the removal of sand;

Figure 2 shows an axial section of the apparatus on a larger scale.

In figures 1 and 2, reference numeral 1 denotes the lower part of a well wherewithin an apparatus 2 has been lowered in
30 order to remove sand 3.

The apparatus 2 is attached to a pipe string 4, e.g. in the form of a coillable tubing, adapted to conduct liquid to a jet pump (ejector) 5 assigned to a container 6 for the accommodation and removal of sand 3.

- 5 As known, the jet pump 5 comprises a housing 7. Uppermost within the pump housing 7, a nozzle 8 is disposed. Said nozzle 8 is adapted to create a jet of liquid and pass it with a high speed into one end of a channel 9 which, through one or more lateral gates 10, passes out of the housing 7. The
- 10 cross-sectional area of the channel 9 increases with increasing spacing from the nozzle 8, the channel 9 being assigned at least one such gate 10 conducting liquid through the wall of the pump housing 7 and outwards into the well 1.

- The housing 7 is in connection with the container 6 through
- 15 an outlet opening 11 in the container 6. At the lower end thereof, the container 6 is provided with an aperture 12 forming an inlet for sandy liquid. A flap 13 which is rotatably attached to the container 6 by means of a hinge 14, is adapted to act as a one-way valve, preventing liquid and sand
- 20 from flowing out from the container 6 at the inlet 12.

- The housing 7 and the container 6 are filled with a liquid which normally will be the same liquid as the one within the well 1. In a well 1 filled with gas, liquid supplied to the pump 5 will gradually fill the lower part of the well 1, so
- 25 that the container 6 and the housing 7 are filled with liquid.

- In the area between the nozzle 8 and the channel 9, liquid flowing out from the nozzle 8 and into the channel 9 takes with it liquid within the housing 7. Liquid which is pumped
- 30 out of the housing 7 in this manner, is substituted by liquid from the container 6.

Liquid flowing into the container 6 at the inlet 12, takes with it sand 3 from the well 1. A filter 15 prevents sand 3 from being brought into the housing 7 by liquid flowing through the container 6.

- 5 Gradually, the container 6 is filled with sand 3, and pumping is terminated, the flap 13 then rotating downwards around the shaft (hinge) 14, taking closing position, thus closing the inlet 12. The pipe string 4 carrying the apparatus 2 is pulled out of the well 1, and the container 6 is discharged, 10 leaving the sand 3 at a desired place (in surface position), whereafter the apparatus 2, possibly, is lowered into the well 1 once more.

- In order to give the filter 15 a large surface area in relation to the filter's need of space within the container 6 at 15 the outlet 11 thereof, the filter may have the form of a three-dimensional, hollow cone- or pyramide-shaped body having a downwardly tapering shape, figure 2.

- It should be clear without saying that - in connection with an apparatus whose mode of operation is based on the suction 20 action of a pump 5 into the container 6 and the circulation of the sand-conveying liquid into the container inlet 12, through the container 6, out from the outlet thereof after filtering off sand 3 and out through the liquid-driven (arrow 16, figure 1) jet pump's 5 one or more lateral gates 10 - a 25 degree of filling can be achieved in respect of the container 6 close to 100% if this is desirable. Consequently, through the invention it has been obtained a substantial technical progress with regard to most relevant technique described in the introduction of the specification.

- 30 In practice, the degree of filling achieved/desired may be based on time and based on experiences from various sand removing situations, the jet pump 5 being stopped after the expiration of a predetermined time. Alternatively, a sensor can

be mounted, e.g. at a level corresponding to the desired top level of an amount of sand. The sensor is actuated, e.g. physically, through the growing sand layer, and is adapted to give a signal which is passed to the jet pump 5 and, possibly, also the one-way valve flap 13, in order to cause the jet pump 5 to stop and the flap 13 to pivot and close the container inlet 12.

The jet pump 5 used to effect the suction of liquid admixed sand (drive liquid 16, often in a mixture with produced liquid) into the sand-accommodating and displaceable container 6 of the sand removing apparatus 2 of the invention, has been found to possess such a superior efficiency and reliability as the drive device of the apparatus 2 that such water-driven jet pumps 5 seem to hold a unique position in the present connection.

Thus, the invention consists, besides the combination of constructive features of the sand removing apparatus, in a use of a jet pump (ejector) as a drive device for the apparatus.

C l a i m s

1. An apparatus (2) for the removal of sand in an underwater well (1), especially in the lower area of the well (1), in connection with the recovery of oil or gas, said apparatus (2) comprising a displaceable sand-accommodating container (6) having a closable inlet (12) for allowing a flow of sand into the container (6) together with a carrier fluid in the form of a liquid and an outlet for the discharge of this accommodated sand on a suitable place after the container's displacement thereto,
c h a r a c t e r i z e d i n that the container (6) has a separate, closable inlet (12) and a separate outlet (11) as well as an intermediate filter (15) retaining sand within the container (6) but letting liquid there-through; that the outlet (11) of the container (6) is assigned to the suction side of a drive device in the form of a pump (5) the pressure side thereof being in fluid communicating connection to the surroundings within the underwater well (1), in order to establish an underpressure within the container (6) for sucking in liquid taking with it sand and an escape possibility for this liquid after the sand has been filtered therefrom.
2. An apparatus (2) as set forth in claim 1, c h a r a c t e r i z e d i n that said separate inlet (12) is provided with a one-way valve (13,14).
3. An apparatus as set forth in claim 2, c h a r a c t e r i z e d i n that the one-way valve (13,14) is a flap valve.
4. An apparatus as set forth in claim 3, c h a r a c t e r i z e d i n that the valve flap (13) which, substantially, has a rectangular circumferential shape, is pivotally disposed at one edge on an edge portion of the

container (6) defining one side of a rectangular valve aperture (12) complementarily corresponding thereto.

5. An apparatus as set forth in any one of claims 1 - 4, characterized in that the separate inlet (12) and the separate outlet (11) are disposed in two opposite side walls, e.g. bottom and top wall as referred to the position of use, and that said filter (15) is disposed immediate adjacent the outlet (11), its circumference extending radially outside the circumference of the outlet (11) as well as being attached sand-tightly to the container wall in which the outlet (11) is disposed.
6. An apparatus as set forth in any one of the preceding claims, characterized in that the filter (15), in order to give it a large surface area in relation to the need of space thereof within the container (6), is shaped as a hollow cone- or pyramide-shaped body tapering in a direction away from the outlet (11).
7. An apparatus as set forth in any one of the preceding claims, characterized in that the drive device of the apparatus (2) in the form of said pump (5) is assigned a timed equipment unit stopping the pump (5) and, thus, disrupting the circulation of liquid after a predetermined time has lapsed, corresponding to what empirically corresponds to a satisfactory degree of filling of the container (6).
8. An apparatus as set forth in any one of claims 1 - 6, characterized in that the container (6) is assigned a sensor adapted to react to a growing amount of sand within the container (6) in order to, upon the occurrence of an enclosed amount of sand corresponding to the desired degree of filling, generating a signal transferred to at least the pump (5) or the drive means (16)

thereof, to stop the pump (5) and to put the apparatus (2) out of operation.

- 5 9. Use of a jet pump (ejector) as drive means for an apparatus (2) for the removal of sand (3) from an underwater well (1), where the sand removing apparatus (2) assigned said jet pump (5) is adapted to be connectable to the free end of a pipe string, e.g. in the form of a coilable tubing (4).
- 10 10. Use of a jet pump (5) in the form of a liquid-driven pump the pressure side thereof being in liquid communication with the surroundings in a well (1) through one or more lateral gates (10) through the wall of the housing (7) of the jet pump (5).

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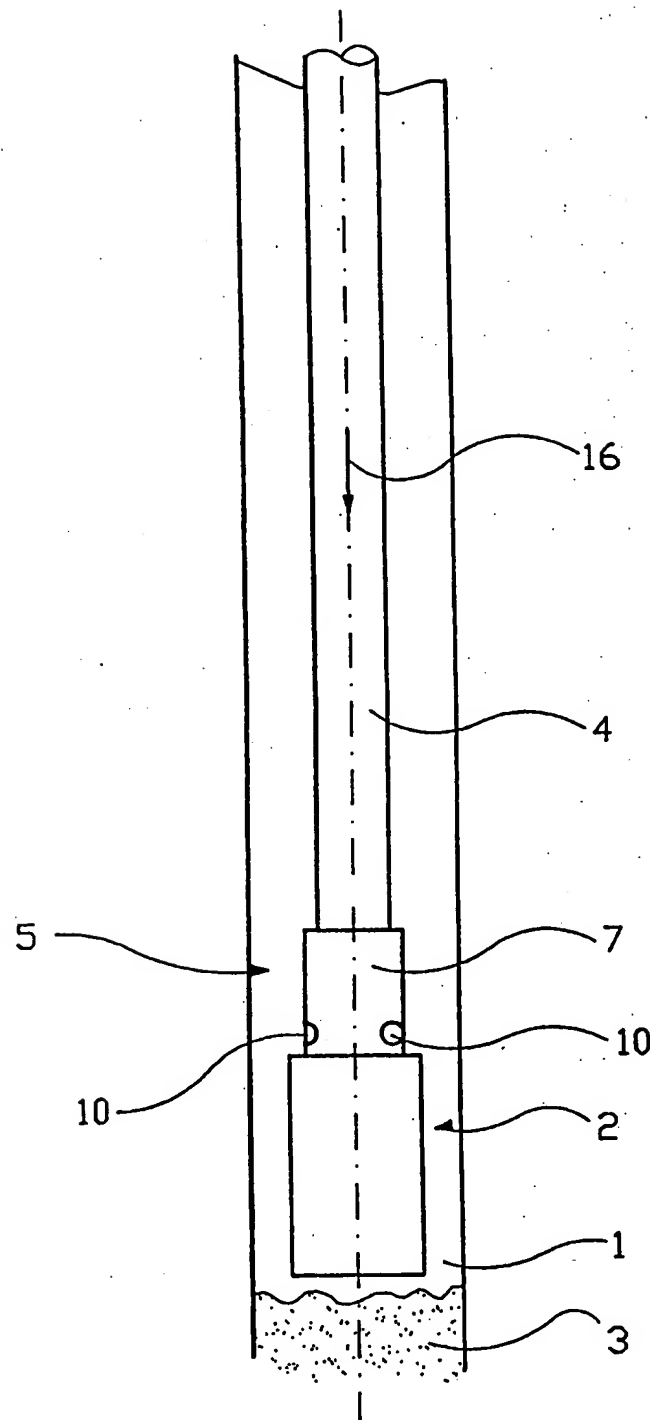


Fig. 1

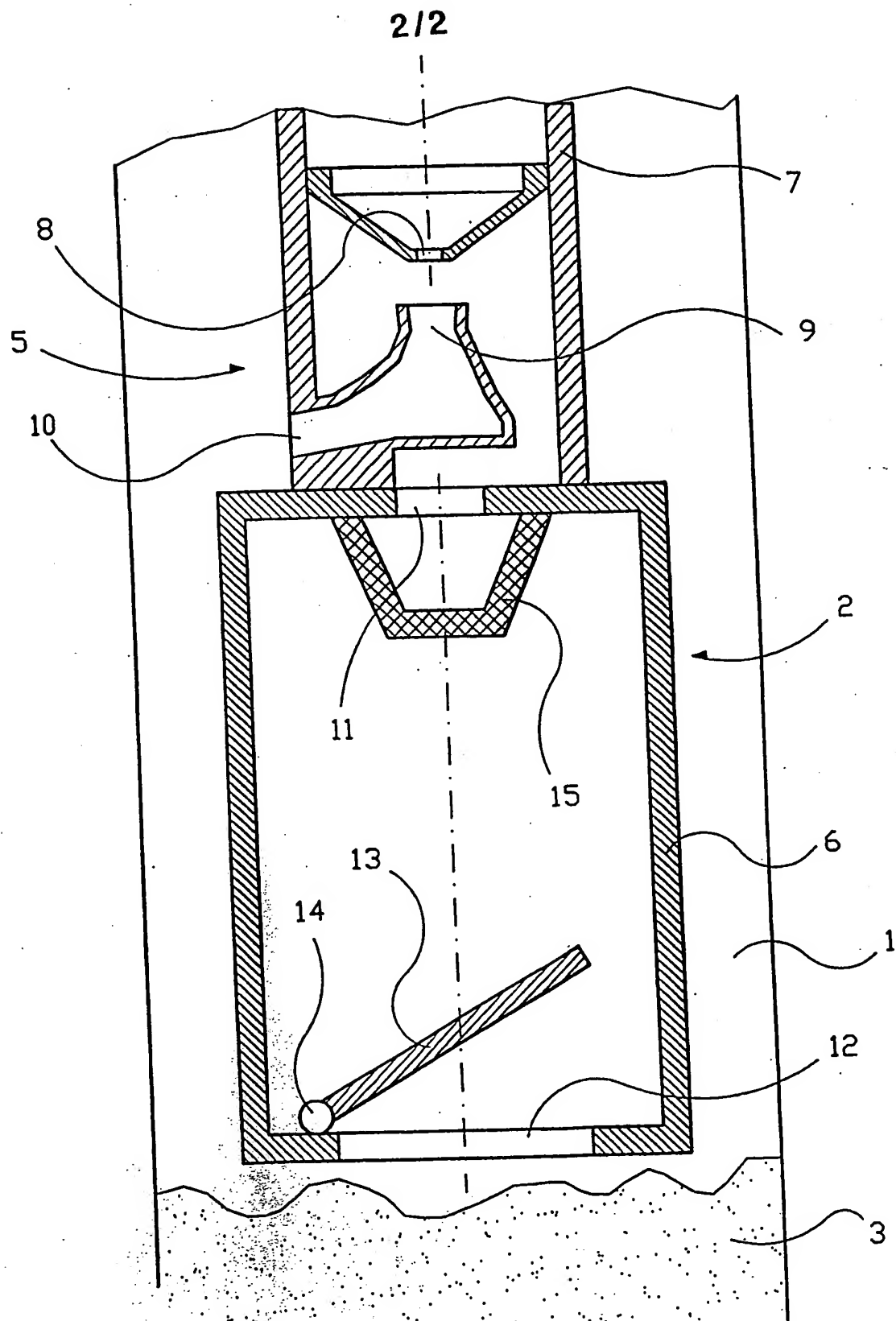


Fig. 2

INTERNATIONAL SEARCH REPORT

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International application No.

PCT/NO 98/00310

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: E21B 37/00, E21B 27/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: E21B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

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C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|-----------|---|-----------------------|
| X | DE 523514 C (W. BRECHTEL), 24 April 1931 (24.04.31) -- | 1-5 |
| X | US 4190113 A (W.O. HARRISON), 26 February 1980 (26.02.80), column 4 - column 6, figures -- | 1-5 |
| X | US 5095976 A (B.D. APPLETON), 17 March 1992 (17.03.92), column 5 - column 6, figure 2 -- | 1-5 |
| X | DE 19721823 A1 (BILFINGER + BERGER BAUAKTIENGESSELLSCHAFT), 23 July 1998 (23.07.98), figure 1, -claims 1-11 -- | 1-2 |

☒ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

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Date of the actual completion of the international search

28 January 1999

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| C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT | | |
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| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
| X | US 4744420 A (J.C. PATTERSON ET AL), 17 May 1988 (17.05.88), figure 2, claims 1-17 -- | 9-10 |
| X | US 5033545 A (T.A. SUDOL), 23 July 1991 (23.07.91), figures 1,2,4,5, claims 1-26, abstract -- ----- | 9-10 |

INTERNATIONAL SEARCH REPORT

Information on patent family members

21/12/98

International application No.

PCT/NO 98/00310

| Patent document cited in search report | | Publication date | Patent family member(s) | | Publication date |
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| US | 5095976 A | 17/03/92 | NONE | | |
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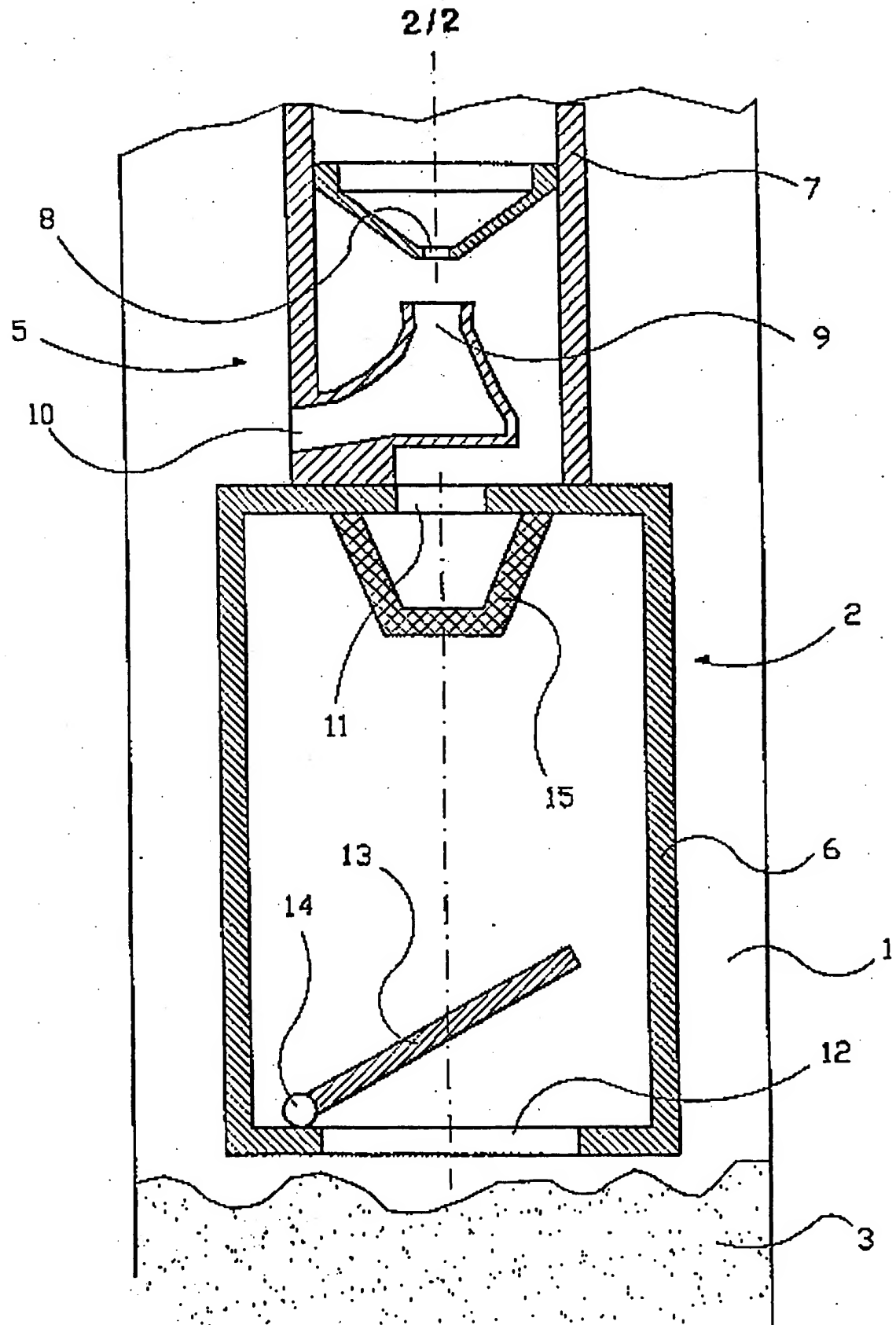


Fig. 2

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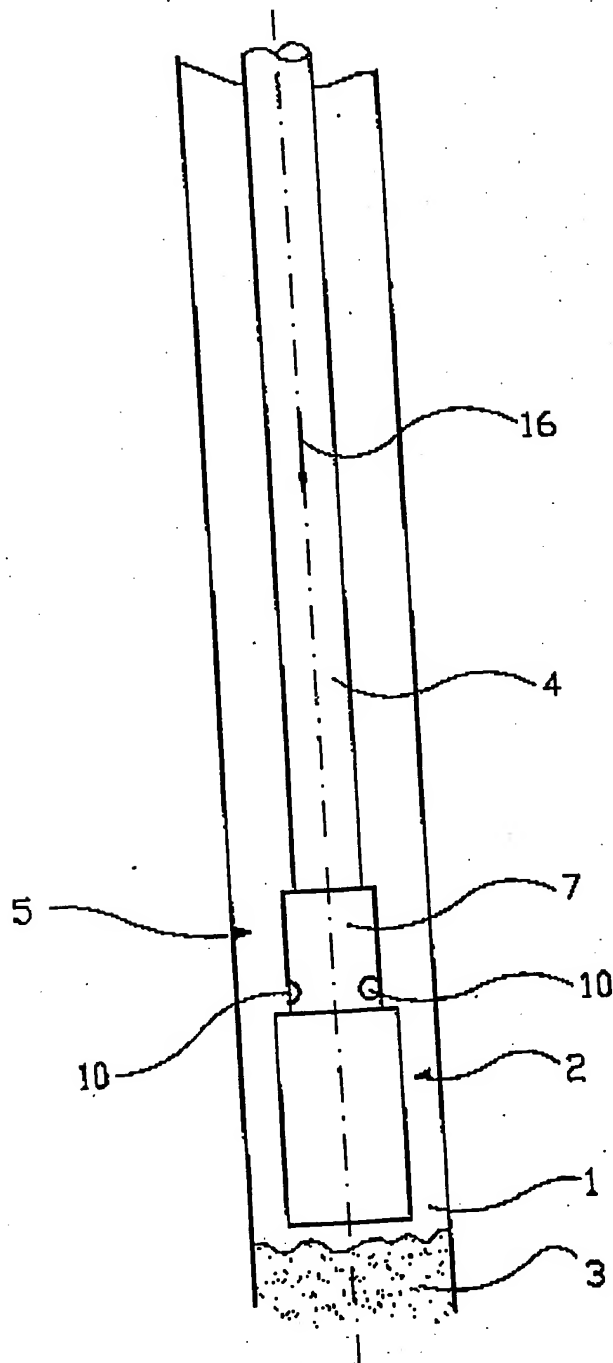


Fig. 1